Table of Contents

E46 Lighting Systems

Subject **Page**

Subject **Page**

E46 Lighting Systems

Model: E46

Production: From Start of Production

OBJECTIVES

After completion of this module you will be able to:

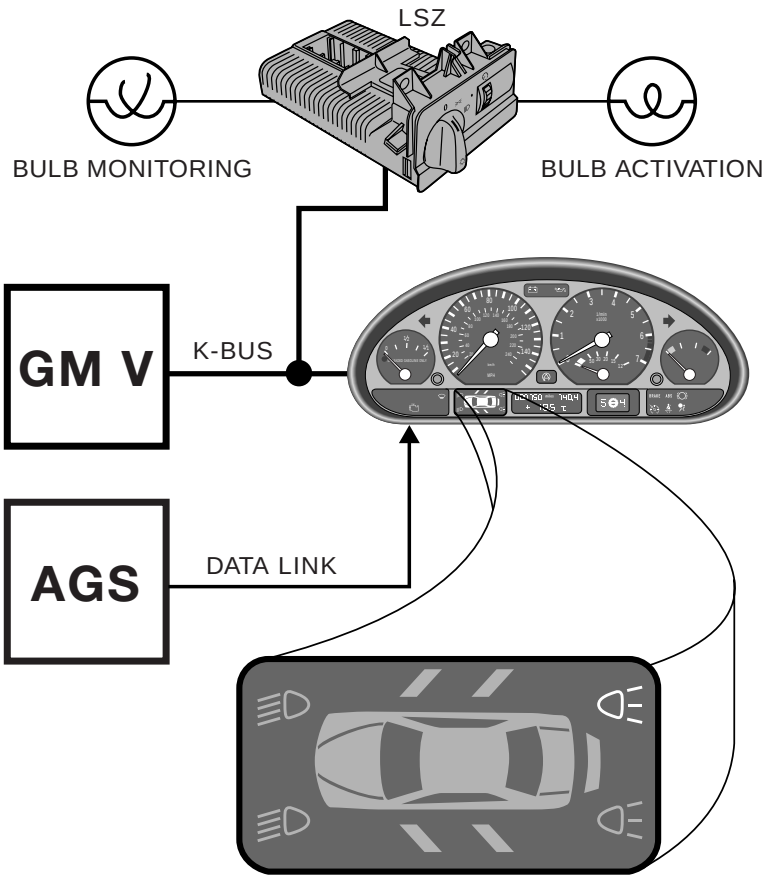
- Understand the lighting systems used on E46
- Identify and locate lighting system components
- Diagnose lighting system concerns

E46 Lighting Systems

The E46 lighting system consists of a Light Switch Center (LSZ) module which controls all exterior lighting. In addition to the electronic control and monitoring system for the external vehicle lights, the LSZ contains the switch for parking lights/low beam, the push buttons for fog lights as well as the potentiometers for instrument lighting.

The LSZ provides the functions of the LCM including:

- Hot and cold monitoring of the exterior lights.
- Emergency lighting function
- Short circuit protection
- Redundant storage of mileage and SI data



System Components

The lighting system components on the E46 include:

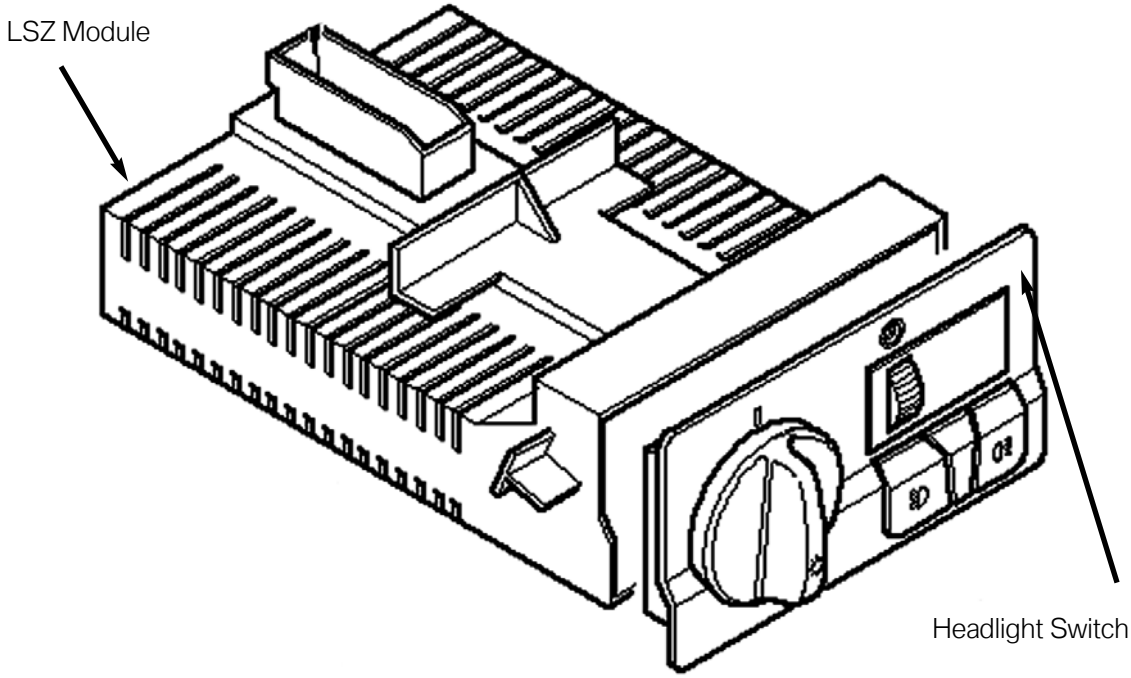
- LSZ control module
- LSZ switch assembly
- High-low beam/turn signal switch
- Brake light switch
- Hazard warning light switch
- Fog light relay
- Exterior lights
- Dash/LCD lighting
- RLS (if equipped from 2002)

LSZ Control Module

The LSZ control module contains the electronics for the control and monitoring of the exterior lighting. The LSZ module is mounted behind the headlight switch to the left side of the steering wheel.

There is a single connector on the module for all inputs and outputs.

From 2002, there some changes to the LSZ module. These include a modified PWM signal for lighting control (freq 80hz), there a additional outputs circuits added for rear brake lights and bi-xenon systems and a new headlight switch to accommodate RLS.



LSZ Switch (Headlight Switch)

The headlight switch is mounted on the front of the LSZ and is connected via a ribbon cable. The headlight switch provides inputs to the LSZ for the operation of the parking lights, headlights and the instrument panel dimming.

The switch is a separate component from the LSZ and can replaced as a separate part.

There is also a phototransistor located on the face of the headlight switch which provides ambient light signals. The LSZ uses these signals to adjust the instrument cluster illumination during varying ambient light conditions (i.e. entering a tunnel etc.).

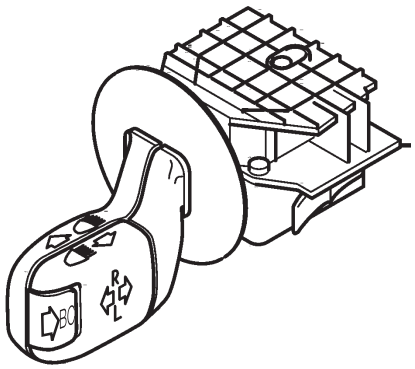
There are two variations of the headlight switch, the original version contains the headlight on/off switch, the dimmer thumb wheel fog light switch (if equipped) and the phototransistor, the updated version includes an additional switch position for the RLS functions.

Headlight Switch (from start of production)

Headlight Switch (with RLS function)

High Beam/Turn Signal Stalk Switch

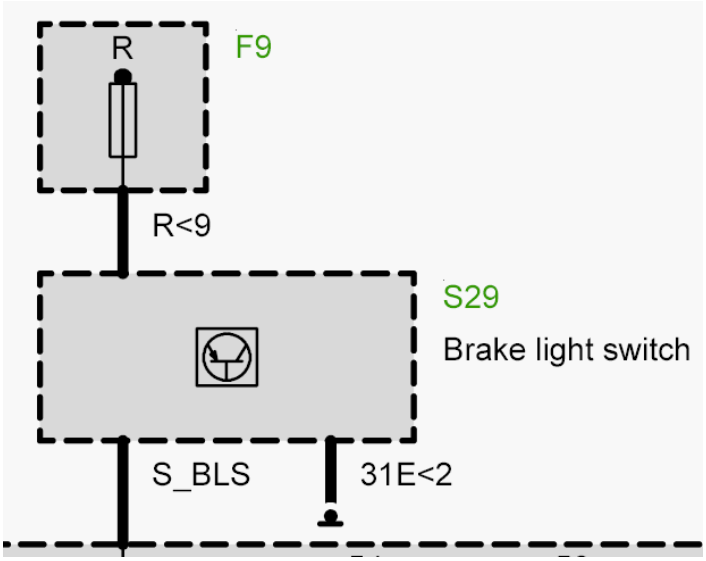
The high beam/turn signal switch is located on the left side of the steering column. The switch provides a coded ground input to the LSZ to activate the turn signals. The switch also provides input for the high beam and “flash to pass” functions.



Brake Light Switch

The brake light switch provides input to the LSZ for brake light control. The switch provides a B+ signal when the brakes are applied. The switch is also monitored by the LSZ for faults.

The brake light switch provides a low voltage digital signal to the LSZ when the brake lights are not actuated. If this signal is interrupted the LSZ interprets this as a faulty brake light switch and initiates emergency mode.



Hazard Warning Switch

The hazard warning switch is located in the center console and provides a ground input to the LSZ module.

Fog Light Relay

The fog light relay (if equipped) is located behind the glove box. It is controlled as a direct output of the LSZ.

Rain and Light Sensor

Beginning in 2002, the Rain Sensor was replaced by the new Rain and Light Sensor (RLS). The RLS is connected to the K-Bus and provides the LSZ (and other modules) with information regarding ambient light conditions.

With the headlight switch set to “A” position, the headlights will automatically be switched on when the ambient light conditions are reduced.

The rain sensing electronics of the RLS only pertain to wiper operation. The operation of the headlights are not affected.

Exterior Lighting

Headlights

From start of production the E46 was available with conventional halogen headlights as in the past. The headlights are arranged in the familiar 4 headlamp configuration.

As an option, Xenon headlamps became available from the start of production in 1999. The Xenon system is use at that time was manufactured by Bosch. This system remained in use until the 2002 model year when the Bi-Xenon lights came into use.

Tail Lights

The Tail lights is use from the start of production (99 model year) are conventional filament type (incandescent) bulbs. These bulbs are replaceable and are controlled by the LSZ using pulse width modulated signals.

Brake Lights

The brake lights used on the E46 are conventional filament type bulbs. This includes the third (center) brake light.

E46 Convertible Third Brake Light

The E46iC from 2002, uses Neon technology for the third brake light which is mounted in the trunk lid. The remainder of the exterior lighting circuits carry over from the E46 Sedan and Coupes. The Electronic brake light switch is the input to the LSZ for brake light activation. The LSZ, as an output, provides power to the Neon light module for activation of the light. The light module consists of the ignitor, and Neon tube.

Advantages of Neon Technology

The use of Neon lighting in an automotive applications provides the following advantages:

- Light failures caused by shock and vibration are reduced due to the lack of a filament in the Neon bulb.
- The average bulb life is improved
- The design of the Neon bulb housing allows for more flexibility in styling. The Neon tube can conform to the contour of the vehicle.
- Amber Neon allows the use of clear lenses (for vehicle color schemes)
- Neon technology enhances safety because of the extremely fast ignition time which allows the other driver's more time to react.

Principle of Operation

Lamp Monitoring

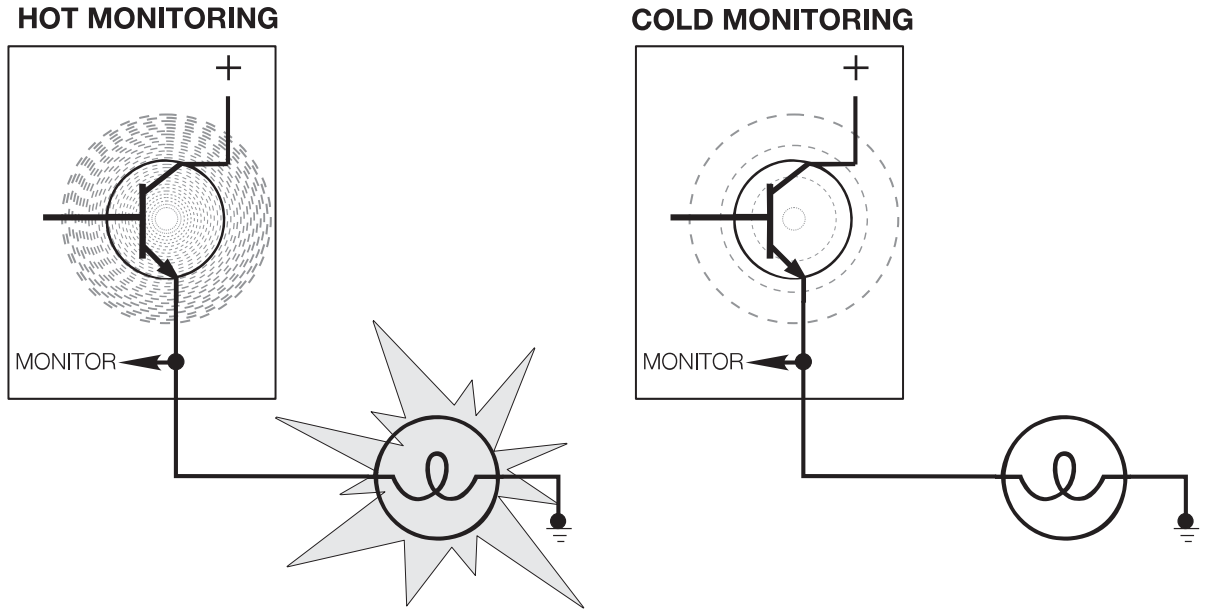
Lamps monitoring on the E46 is a function of the LSZ module. The module report bulb status to the instrument cluster via the K-bus to allow the display of faulted bulbs to be represented in the LED pictogram.

The lamps are monitored in OFF and ON status, this is referred to as Hot and Cold monitoring.

Cold monitoring in the OFF status takes place by briefly sending a low voltage pulse through the lamp filament. The voltage pulse, which is in the millivolt range, does not supply enough current to illuminate the lamp filament. But the voltage pulse is sufficient enough to allow the circuitry of the LSZ to measure voltage drop.

Therefore the lamp filament can be monitored in the OFF status. This allows to driver to be warned before the lamp is needed. This of course enhances the safety of the driver and other road users.

Hot Monitoring, as it suggests, allows for the monitoring of the lamp filament when active. The LSZ measures the voltage drop of the circuit and compares it to stored values. The appropriate check control pictogram is illuminated when a faulty lamp is detected.



Note: Due to the Hot and Cold monitoring capabilities, it is very important to use the specified lamps with the correct wattage rating. Using substandard or incorrectly rated lamps could affect the lamp monitoring and cause erroneous check control messages. Also, if the battery voltage drops below approx. 9.5 V, the lamp status can no longer be monitored or output.

Emergency (Failsafe Lighting)

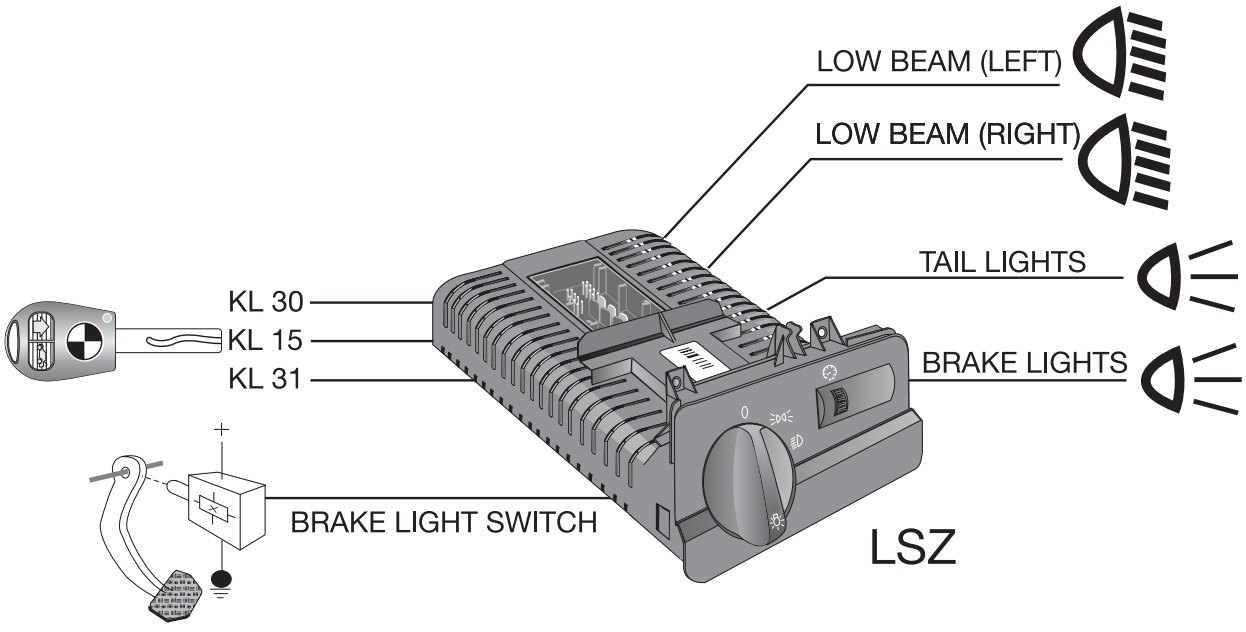
The LSZ provides emergency lighting in the event of a control module failure. If the processor of the LSZ control module fails, back up hardware will allow the following lighting circuits to function:

- Low Beam headlights
- Tail lights
- Parking Lights
- Brake Lights

The headlights and tail lights will come on as soon as KL 15 is switched on, the brake will operate when the brake pedal is pressed.

Direction indicators, hazard warning lights, high beam, headlight flasher, fog lights and rear fog lights cannot be switched on.

Diagnosis is not possible and if in emergency mode, the light switching center must be replaced.

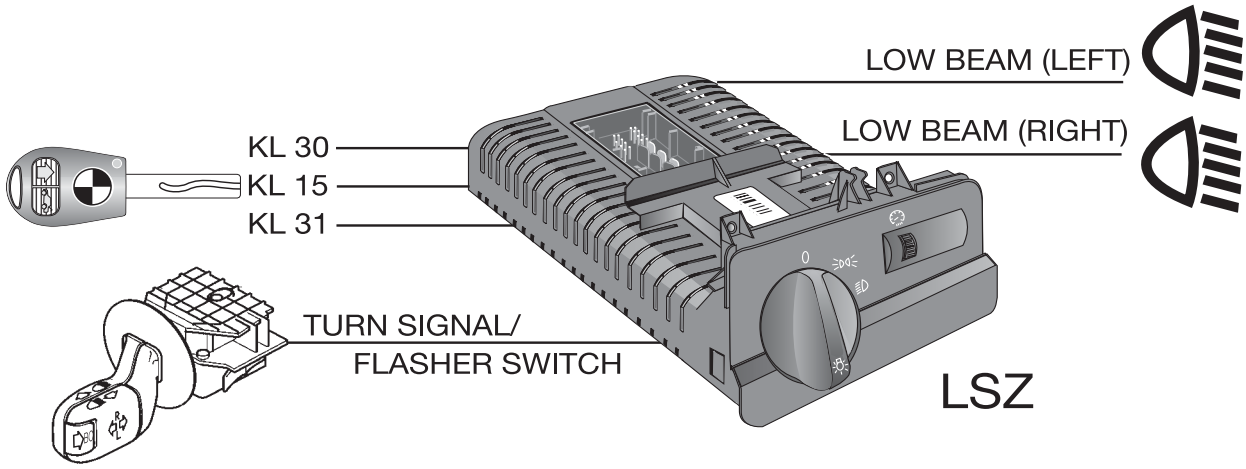


Home Lighting

This convenience feature provides lighting for the driver and passengers to leave the vehicle and enter their house.

The feature is switched on by activating the headlight flasher switch after the lights and ignition are switched off.

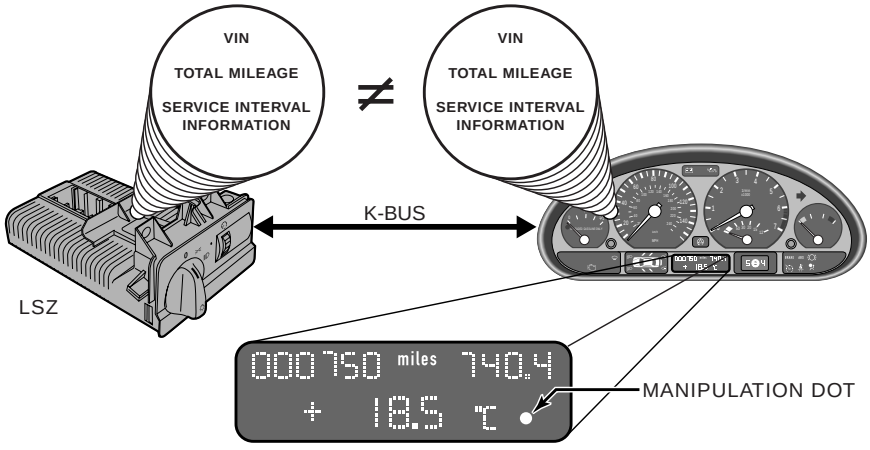
The feature is switched off after the coded time delay or by switching the ignition switch to ON.



Redundant Storage

The LSZ serves as the redundant storage module in parallel with the instrument cluster. This includes all data used for vehicle identification which is encoded on the assembly line. In addition the total mileage and SI data are also stored in the LSZ.

If either the Cluster or LSZ has to be replaced, the data is taken from the remaining module and transferred to the replacement unit. This can only occur ONCE the VIN has been entered into the replacement unit. Once the VIN is entered, the module becomes part of the vehicle and can not be interchanged with another vehicle.



Crash Control Activation

During an impact which involves the deployment of the airbags, the MRS module will send a “crash telegram” message over the K-Bus. The ZKE system will respond by unlocking the doors (if locked) and turn on the interior lights.

The LSZ will respond by activating the hazard flashers as well.

Fog Lights

The LSZ is also for switching on the control circuit of the fog light relay. The fog light switch is integrated into the LSZ control switch. As per safety and governmental regulations, the fog lights can only be switched on when the parking or headlights are on.

Dimmer Circuit (KL58g)

The LSZ controls the external KL58g circuit via pulse width modulation. The intensity of the illumination is controlled my modulating the pulse width which in turn increases or decreases circuit current.

The KL58g circuit is an output of the LSZ and includes the illumination circuit control for the IHKA module, ashtray/lighter, and the switches for power windows, sunroof and LSZ switch etc.

Other circuits are controlled by a “KL58g” telegram message over the K-Bus, these include the instrument cluster and MFL illumination.

In addition to the “thumb wheel” control of the dimmer circuit, the illumination is also influenced by the phototransistor in the LSZ switch.

Indicator Lamps

The LSZ also controls the various indicator lamps via the K-bus. The indicators for the directionals, fog lights, high beams and the LED’s in the pictogram are also triggered based on K-Bus telegrams from the LSZ.

Rain/Driving-Light Sensor (RLS)

The new RLS replaces the familiar Rain Sensor already in use. The RLS now has the added functions of monitoring ambient light conditions to influence the operation of the headlights.

The driving lights (headlights) are turned on and off automatically based on input from the RLS depending upon ambient light conditions.

The new RLS contains two additional optical sensors have been integrated in the sensor housing. The RLS continues to use the same rain sensing electronics as used on the previous AIC system. The two additional light sensors are used for headlight operation.

The two sensors have the following function:

- Sensor number 1 is a surrounding-light sensor that records the light intensity in a wide angle above the vehicle.
- Sensor number 2 is a frontal-light sensor that records the light intensity in a narrow angle in in front of the vehicle. A processor measures and determines which sensor is switched on.

The following conditions are monitored by the (RLS):

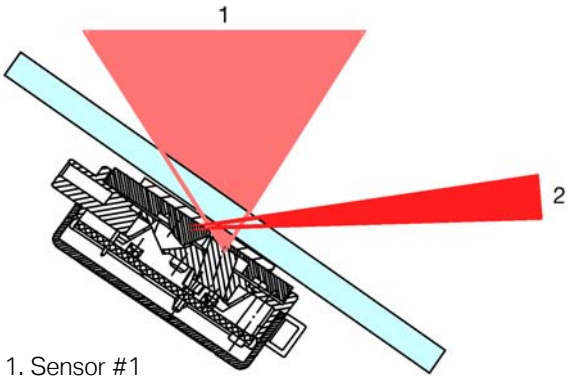
- Dawn/dusk
- Darkness
- Driving through a tunnel
- Precipitation such as rain or snow

Note: When the wiper switch is in the intermittent position, The RLS knows the switch is on by the frequency of the windshield wipers. (The frequency for the intermittent wipers is 15 wiping cycles per minute. If the wiper switch is in position I or II the RLS knows the wipers are switched on permanently.

If wiper switch condition is on, The RLS in the E46 transmits the information thru the K-bus to the central light switch. (LSZ).

If the RLS switch position("A") on the LSZ has been selected, the exterior and instrument lights are activated by the LSZ under the following conditions:

- One of the above RLS conditions is satisfied.
- The front fog lights are switched on.



1. Sensor #1
2. Sensor #2

Light switch on LSZ
(shown in “A” position)

Note: If the LSZ front fog light is switched on and one of the above mentioned RLS conditions is satisfied, the exterior lights will only go out after the front fog lights have been turned off.

In addition, the lights are switched on in the event of the following malfunctions.

- The RLS has detected a sensor fault.
- Communication between the RLS and the LSZ is disturbed.

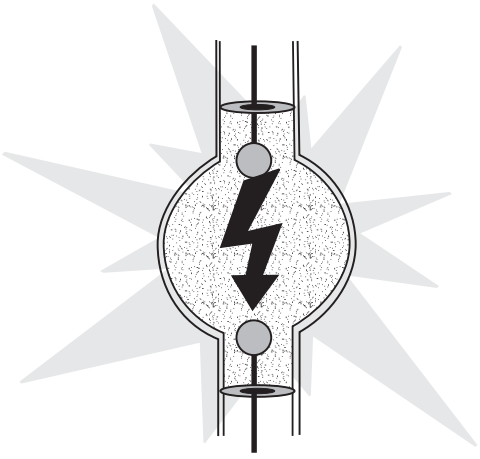
The following lights are switched by the LSZ:

- Terminal R turns on the parking light, the low beam headlight, the license plate light and the instrument lights.
- Terminal 15 turns on the parking light, the low beam headlights, the license plate light. In order to switch the parking light on the LSZ switch must be set to parking light position on.
- With the ignition switch in the “0” position, the exterior and instrument lights are switched off.

The sensitivity of the RLS can be adjusted by means of the car memory function.

Safety Notice!!! **During bad weather and fog the driver must switch on the fog lights manually. The automatic driving-light control will not turn the fog lights on during bad weather conditions.**

Xenon Headlight Systems



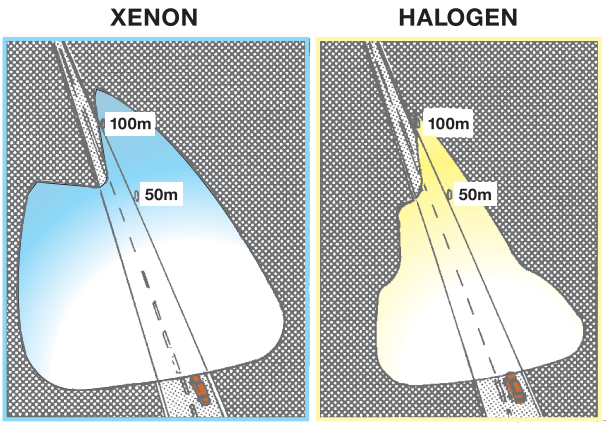
In order to improve night time driving visibility, Xenon headlight systems were developed for the automotive industry. Xenon technology is also referred to as High Intensity Discharge lighting or HID.

For BMW vehicle Xenon technology was first introduced to the US market in 1993 on the E32 750iL. Since this time Xenon technology has evolved and spread throughout the model lineup.

The first thing noticed about Xenon lamps is the blue/white appearance of the headlights.

There are numerous benefits to Xenon headlights and these include:

- Longer bulb life - typically the xenon bulbs will last from 3 to 5 times longer than conventional halogen bulbs.
- Increased light output - Xenon headlights produce 2.5 to 3 times more light (lumens) than halogen headlights.
- Blue/white light - The blue/white light emitted from Xenon headlights simulates a natural daylight appearance as opposed to the yellowish light from halogen bulbs. The light color of a light source is measured in color temperature (do not confuse with thermal temperature). Color temperature is measured in Kelvins (K). The higher the number, the whiter the light appears to be.
  - Natural daylight = 4,500 to 5000 K
  - Xenon headlights = 4,000 to 4,500 K
  - Halogen headlights = 3,200 K (yellow)
- Better driving visibility - the combination of higher lumens and color temperature provides a superior lighting source. The beam is wider and brighter in front of the vehicle than conventional halogen bulbs improving safety and driver comfort.



LWR

On vehicles equipped with Xenon headlights systems, it is necessary to prevent the light beam from affecting oncoming traffic. The Headlight Beam Throw Control (LWR) system is used to adjust the headlights horizontally (on a vertical plane). The is accomplished by using stepper motors in the headlight assembly.

The stepper motors are controlled by the LWR control module based on inputs from front and rear mounted ride level sensors.

As the vehicle suspension is loaded by driving or by passengers and cargo, the LWR module corrects the headlight position. This ensures the optimum headlight adjustment.

Version Identification

Xenon systems on BMW vehicles are supplied by two manufacturers - Bosch and Hella. These systems vary between models.

The first version system on the E38 is referred to as Generation 2.1 an can be identified by the flat bottom edge on the headlight housing.

The Generation 3 system has been introduced on the 1999 model year E38 and can be identified by the rounded (scalloped) edge of the headlight assembly.

Headlight Replacement Parts

In previous model years, individual replacement parts were not available for headlight assemblies. This was due to the Federal Motor Vehicle Safety Standards (FMVSS) relating to the pitting or corrosion of the reflector components in non-sealed beam headlight assemblies.

BMW has submitted corrosion test data for headlight components which have passed the FMVSS providing the availability of headlight assembly spare parts. This approval has been given for all Bosch headlight assemblies (including halogen).

Vehicle Model	Model Year	Manufacturer/Version	LWR (Yes/No)	Individual replacement parts availability
E32 (750iL)	93-94	Hella (Light & Control module) Generation 1	No	No
E38 (750iL)	95-98	Bosch (Light & Control module) Generation 2.1	No	Yes
E38 (All)	99-01	Bosch (light) and Hella (control module) Generation 3	Yes	Yes
E39 (All)	99-02	Hella Generation 3	Yes	No
E46	99-	Bosch Light and Control Module	Yes	Yes

Xenon High Intensity Discharge Bulbs

Xenon bulbs are identified as D2-S. Xenon bulbs illuminate when an arc of electrical current is established between two electrodes in the bulb. The xenon gas sealed in the bulb reacts to the electrical excitation and head generated by the current flow. The distinct blue/white light is the result of the xenon gas reacting to the controlled current flow.

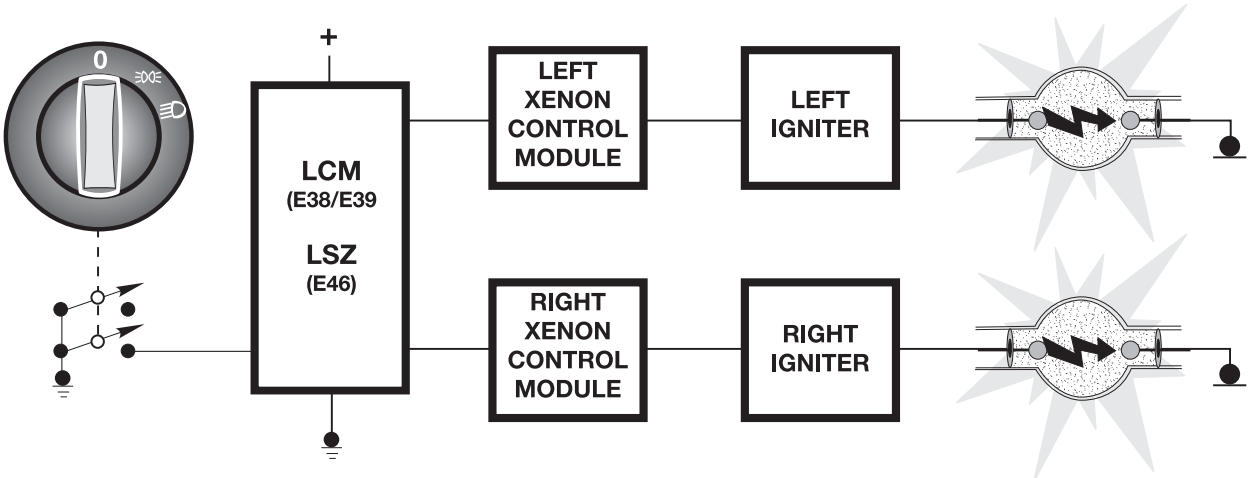
Phases of Bulb Operation

- Starting phase - the bulb requires an initial high voltage pulse of 18-25kV to establish the arc.
- Warm up phase - Once the arc is established, the power supply to the bulb is regulated to 2.6 amps generating a lamp output of 75 watts. This is the period of operation where the xenon gas begins to brightly illuminate. The warm up phase stabilizes the environment in the bulb ensuring continual current flow across the two electrodes.
- Continual phase - once the warm up phase is completed, the system switches to a continuous mode of operation. The supply voltage for the bulb is reduced and the operation power required for continual bulb illumination is reduced to 35 watts which is less than a conventional halogen bulb.

Functional Description

To regulate the power supply to the bulbs, additional components are required. The xenon control modules (1 per light) receive operating power from the lighting control module (LSZ E46) when the headlights are switched on.

The xenon control modules provide the regulated power supply to illuminate the bulbs through their phases of operation. The igniters establish the electric arcs. Integral coils generate the initial high voltage starting pulses from the control module provided starting voltage. Thereafter they provide a closed circuit for the regulated power output from the control modules.

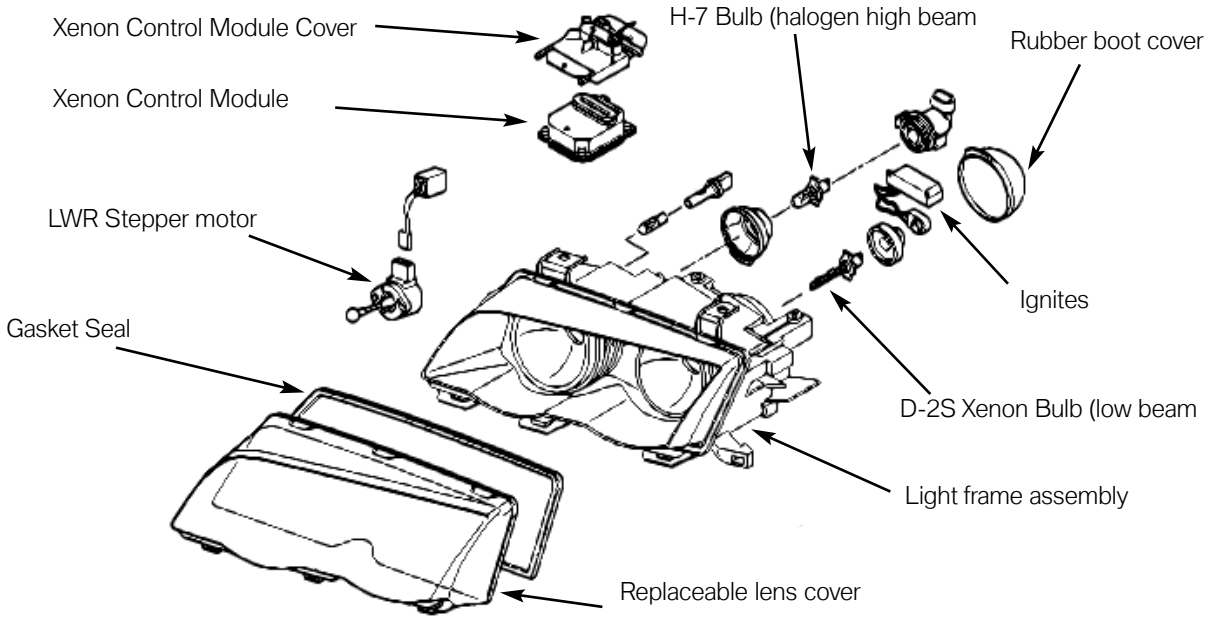


Xenon Bulb Monitoring

Xenon bulb function is monitored by the LSZ. The bulbs are only "hot" monitored. Cold monitoring is not possible since the lighting control module is not in direct control of the xenon bulb. For this reason cold monitoring for low beam headlights is encoded off in the lighting control module for Xenon headlight equipped vehicle.

The lighting control module detects xenon bulb failure via a reduction in current flow to the xenon control module. When a bulb fails, the xenon control module's current consumption drops to 60mA indicating unsuccessful xenon bulb illumination. The lighting control module then posts the appropriate matrix display message or LED illumination in the Check Control Pictogram display of the E46 and E39 Low Instrument Clusters.

Xenon Headlight Assembly Components



Bi-Xenon Headlights

At BMW, the bi-xenon light now replaces the conventional headlight with H1 lamp bulb. In contrast to the previous Xenon headlamp design, the new Bi-Xenon headlight allows for low beam and high beam operation from the same lamp.

The previous system only used a conventional halogen bulb for the high beam. The Bi-Xenon system still utilizes the halogen high beam, but only for “flash-to-pass”.

The bi-Xenon consists of a new D2S/R lamp. An electromagnetic shutter is used to direct the light beam in either “low beam” or “high beam” mode. During low beam operation, the shutter covers a part of the reflector assembly which reduces the light intensity and re-directs the beam to a lower angle to avoid blinding oncoming traffic.

In the case of high beam, the halogen lamps are supplemented by an enlargement of the focus angle of the xenon driving light. To create the high beam distribution, the shutter again re-directs the beam to a higher angle.

As mentioned previously, the headlight flasher (flash to pass) still uses the halogen bulbs.

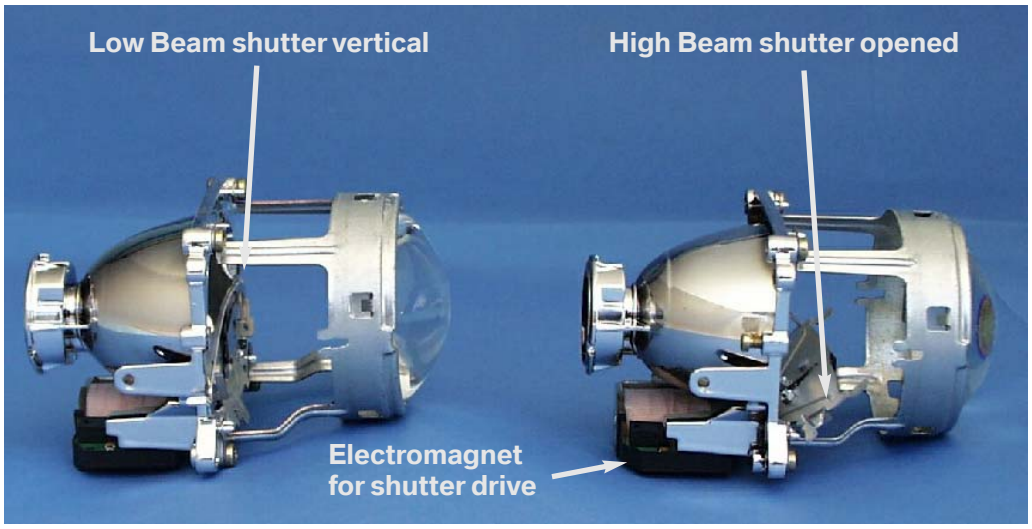
The bi-xenon light does not have self-diagnosis capabilities. In automatically running test modules, the functionality of the components is tested. In the event of a fault, fault codes are stored in the fault memory. Status inquiries on the individual functions can be activated in the control-module functions.

Components

Relevant safety and accident prevention regulations must be observed when conducting all tests and work on the xenon light system. The xenon light headlight system carries dangerous high voltages!

Bi-Xenon Headlight

Bi-xenon headlights consist of headlights with D2S/R bulbs (bulb with a xenon gas charge) an electronic control facility (ignition device and control module)



Electrical control facility for bi-xenon headlights

The electronic control facilities consist of bi-xenon control module and bi-xenon ignition device. The ignition unit generates the high voltage to initiate the arc needed to ignite the D2S/R bulb.

Diagnosis

Xenon control modules are not connected to the diagnostic link. However, the vehicle specific Lighting Control Module (E38/E39 - LCM or E46 - LSZ) does incorporate xenon headlight specific diagnosis up to the xenon control module.

Xenon Headlight Testing

Warning: Xenon headlight control systems generate high output voltage. Prior to headlight removal or testing observe the vehicle warning labels and be cautious by following safe-guards to prevent accidental injury.

All xenon headlight systems (control module, Ignites and bulb) can be tested with Special Test Adapter (P/N 90 88 6 631 000) in conjunction with the DIS Measurement System only.

Refer to SI 04 33 96 for detailed adapter introductory information.

The DIS Measuring System includes all of the cable connection information and test procedures in the “Xenon Preset Measurement”.

The test provides an automatic oscilloscope setup and provides conclusive “defective/not defective” test results.

Xenon Headlight SI/TRI Bulletin

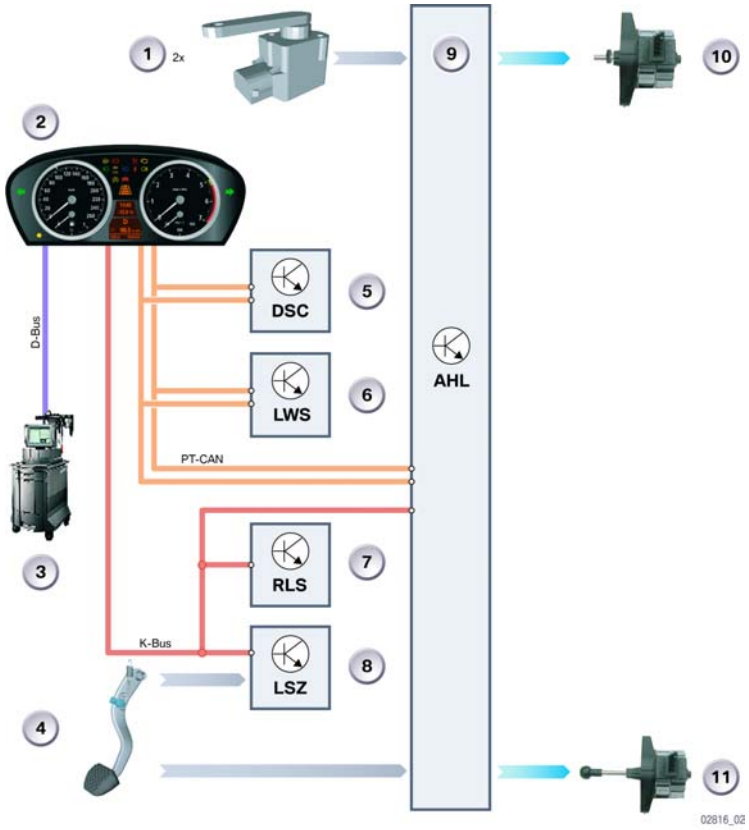
- SI 6308 98: Xenon Headlamp Reduced Service Life - 1999 740iL. This bulletin address a small group of possibly defective xenon control modules. This bulletin uses the special test adapter and specific oscilloscope setup procedures to check the xenon control module output.
- SI 63 02 98: E39 Headlight Alignment Procedure
- SI 63 02 93: Xenon Headlights - Color, Fuses, Warranty
- TRI 63 01 92: Gas Discharge Xenon Low Beam Headlights.

Adaptive Headlights (AHL)

The AHL system also referred to as Adaptive Light Control (ALC) is available on the E46 from 2003. This system is only available with the optional Bi-Xenon headlights.

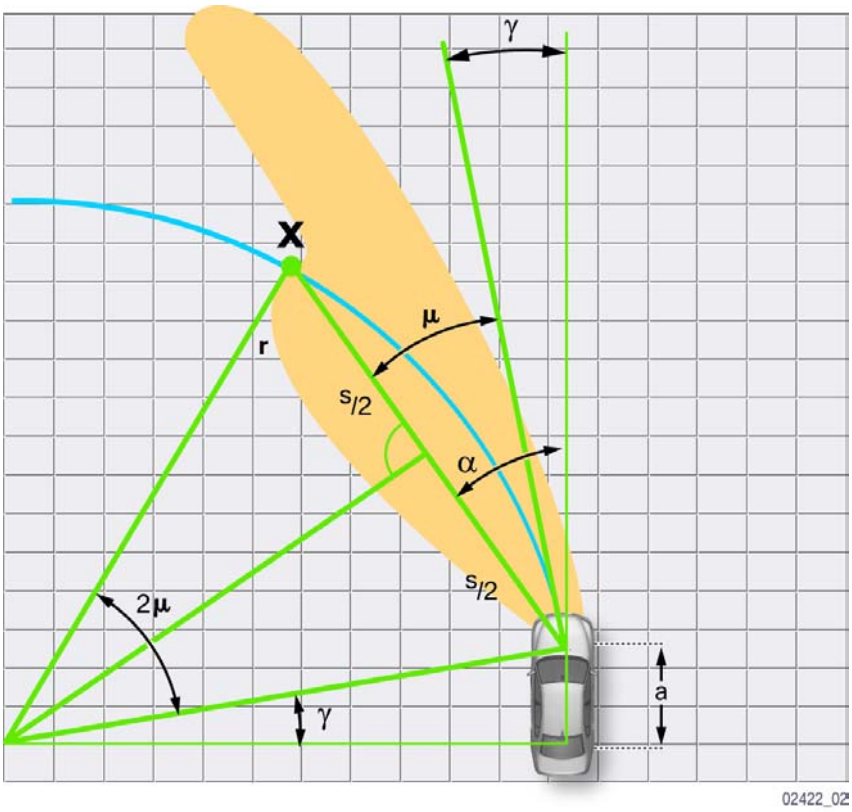
The AHL system allows the headlight to move in a vertical plane which follows the movement of the vehicle. In a turn, the roadway is illuminated completely. This improves visibility in turns and allows for increased safety.

The AHL system also takes over the functions of LWR by adjusting the headlights in a horizontal plane. This prevents the Xenon lights from blinding oncoming traffic.



Index	Explanation	Index	Explanation
1	Ride level sensor (fr/rr)	7	RLS
2	Instrument cluster	8	LSZ
3	DISplus	9	AHL control unit
4	Brake light switch	10	Stepper motor for Vertical movement R/S
5	DSC	11	Stepper motor for Vertical movement L/S
6	Steering angle sensor		

The AHL system adjust the headlights up to 15 degrees for the light on the outside of the turn and 7 degrees for the light on the inside of the turn. These adjustments are based on input from the steering angle sensor, the road speed (from DSC) and the yaw rate input (also from DSC).



Each headlight assembly contains 2 stepper motors for headlight movement. One stepper motor is responsible for vertical movement for the LWS functions. The other is for the horizontal movement for the AHL functions.

The Stepper Motor Controller, located in each headlight assembly, is responsible for the stepper motor functions.

The AHL module is located in the control module carrier behind the glovebox.

Workshop Exercise - Diagnosis

Using an instructor designated vehicle, diagnose the concern listed below. Complete this worksheet using the "Complaint, Cause and Correction" format.

Vehicle: _____ Chassis #: _____ Production Date: _____

Complaint: _____

Cause: _____

Correction:

Classroom Exercise - Review Questions

1. What is different regarding the LSZ in 2002?

2. Explain the difference between “Hot” and “Cold” monitoring:

3. What are some of the advantages of Neon technology?

4. What are the differences/advantages of Bi-xenon headlights as compared to the previous Xenon technology?

5. What occurs when the LSZ is in “Emergency Mode” (failsafe)?

Classroom Exercise - Review Questions

6. Explain the “Home Lighting” feature:

7. What is the purpose of LWR?

8. What influence does the RLS have on headlight operation?